Teleworkbench: User Guide

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1 Introduction

As the demand for using the Teleworkbench is getting higher, I think it is wise for users to have a guidance for using the Teleworkbench: what are requirements to access it - hardware and software, what tasks can/cannot be done, what output the Teleworkbench will produce, and how to get the most out of it. They all will be described in detail in the following sections. If you think that there is still not clear enough for you, you can simply ask me by email to tanoto@hni.upb.de.

2 What is Teleworkbench

I am sure that by the first time of hearing the term Teleworkbench, every one of you will ask what it is. Well, Teleworkbench is a teleoperated platform or testbed for managing multi-robot experiments.

3 Access Requirements

Basically every one of you can use Teleworkbench as long as you are connected to internet. However, to fully utilize the Teleworkbench system, there are some hardware and software requirements. Additionally, you need also to have an account registered in our database.

3.1 Hardware requirements

- PC with fast enough processor
- Internet connection
- Monitor, recommended 800 x 600 pixel
- Input device, mouse or keyboard
- No sound device required (for current version)

3.2 Software Requirements

- Operating system: Windows (recommended XP or 2000) or Linux
- Any internet browser
- Quicktime plugin for Windows for embedded video on website
- Otherwise, any MPEG4 player with xvid codec, such as VLC, mp4player, etc
- OSMO4 player to playback the visualization output file

3.3 Teleworkbench Account Requirement

As a regular user, you can mere do the following activities with the Teleworkbench system:

- controlling the robot remotely (telerobotics)
- turning on the web camera to watch the video taken by the overhead camera
- asking some information related to the position of robots on the field
- retrieving data from the previous experiments from the data repository

As a registered user, you are not only eligible to activities forementioned, but also to the main activity which is setting up and execute experiments using the experiment scheduler. Registered users have higher priority than regular users. It means that any resources that are used by the regular users can be automatically taken and used in experiments set up by registered users. However, the resources used in experiments cannot be accessed by regular users.

4 Scenarios for Teleworkbench

So, after knowing the preparation for using Teleworkbench, we will find out how this testbed can be used. There are mainly four scenarios that we can deploy on the Teleworkbench system. The details will be presented in the following subsections.

4.1 Robot Remote Control

This activities is known as well as telerobotics, which is basically an effort to control a robot remotely. Perhaps some of you might wonder whether it is possible to control a robot remotely using Teleworkbench. Well, the answer is yes and no. This testbed is basically not meant for telerobotics. Therefore, even though users can control the robot via internet, still it would be inconvenient and unreliable. This is due to the delay of the feedback from the Teleworkbench server, in a form of live streamed-video.

Possible application: will follow...

4.1.1 Steps

1. Turn on the webcam:

   - From the Live Camera menu: type the length of the duration and select the time unit. Click 'Start webcam' button. See Figure 1 for reference.

     Soon after the webcamera started, you can watch the live streamed-video on the same webpage (Figure 2).
   - Or, from the Interactive menu: type W,Q,cam,time where cam is the webcam no (there are five webcams but at present there is only one active camera) and time is the video duration in second.

2. Get the handle of one robot:

   R,A,robot_id,mode (0: color id, 1: communication id)

3. Give command to the robot:

   R,C,handle,robot_id,mode,command

   For more detail on command available, please read the appendix.

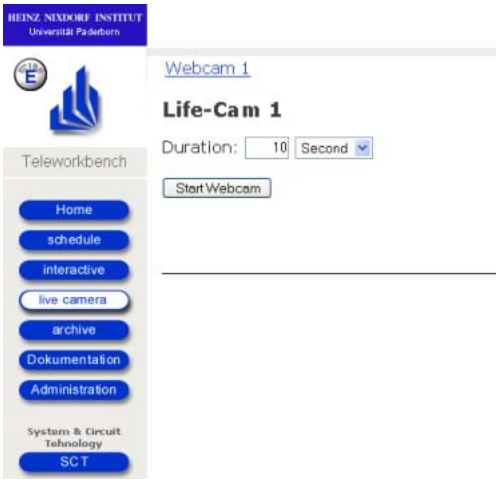


Figure 1: The Live Camera menu. User can activate the web camera for a certain period of time.

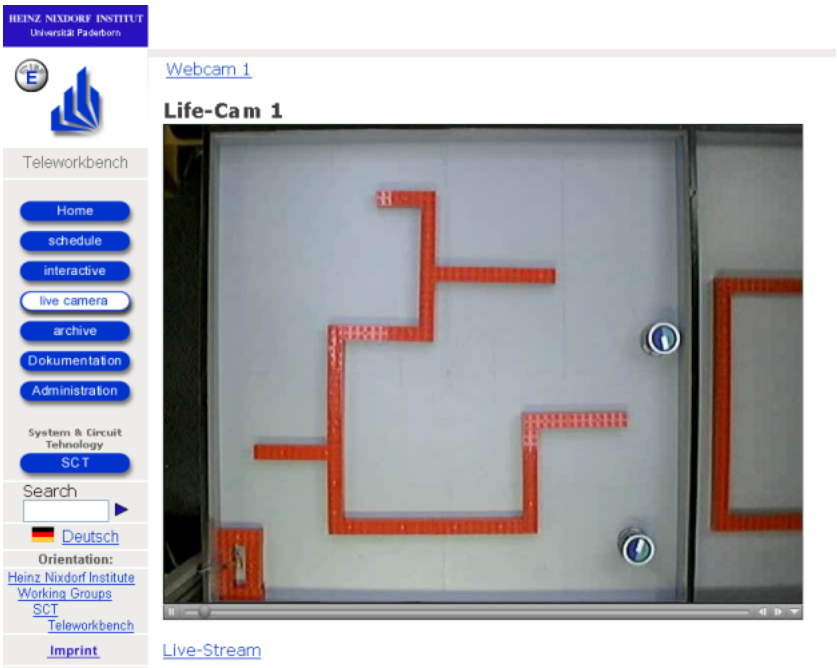


Figure 2: The live streamed-video embedded on the website.

4.2 Running Unregistered Experiments Using Only Robots

Unlike the previous scenario, in this scenario, users can not only remotely direct or control the robots, but they can also download user-defined programs to robots. However, the programs MUST be located in a place reachable by the Teleworkbench server, in this case it MUST be located within our local area network. Thus, for remote users, there is no other way to download any program to robots unless they send the source code to us and let it compiled here.

Since the communication between the webserver and the Teleworkbench server can only be initiated by the webserver, thus there is no information sent to users concerning the download process. What users can do is to ask the server the status of the robot, whether it is still in download mode or not.

As soon as the download process is over, users can command the robots by simply sending the command string as described in the previous scenario.

Possible application: will follow...

4.2.1 Steps

1. Turn on the camera. See 4.1.1 Step 1.
2. Get the handle for a robot. See 4.1.1 Step 2.
3. Download the program.
4. Control the robot if needed.

4.3 Running Unregistered Experiments Using Robots and Virtual Robots

Besides robots, users can also involve one or many computers to act as virtual robots. For example, one computer may be a supervisor for one or many robots, which can give order to robot and retrieve some information concerning the robots. However, since the computers used is not specified in the beginning, the Teleworkbench server does not know about the existence of these computers. The Teleworkbench Server will thus only listening to any connection requests. Consequently, the communication will be only initiated by the computers used as virtual robots. Furthermore, the robots cannot communicate with these virtual robots, thus the virtual robots can only get information from the Teleworkbench server, which is limited only to position information.

Possible application: will follow...

4.3.1 Steps

The step in running this scenario is basically similar to the previous scenario, except that now one or more computers will be used. For security reason, people outside our institute MUST give the program for the virtual robot in the source-code form. Later, we will compile the code and execute it in one of our computers. Users can make the virtual-robot program either for MS Windows or Linux. As a note, the communication between the virtual robot and the Teleworkbench server will be accomplished through socket communication. the detail steps are as follow.

1. Develop programs for virtual robots and send the code to us
2. Turn on the webcam
3. Get the handle for the robot
4. Download the programs to robots
5. Watch the live streamed-video

No	Output Data	Registered Users	Unregistered Users
1	Video Data (MPEG4 video in MP4 container)	YES	NO
2	Position log file	YES	NO
3	Communication log file	YES	NO
4	Visualization Video (MPEG4 video in MP4 container)	YES	NO
5	Experiment log file	YES	NO

Table 1: Output data from Teleworkbench and its accessibility to different type of users.

4.4 Running Registered Experiments Using only Robots

This scenario is rather similar with the scenario in 4.2, except that now users can upload their own programs for robots. Moreover, after the experiment, users can retrieve all information generated during the experiment (see Section 5). Another advantage of being a registered user is that the field can be set-up as requested.

4.4.1 Steps

1. Go to schedule menu (see Figure 3.a).
2. Enter your username and password.
3. Set-up your experiment
   (a) Describe your experiment (see Figure 3.c)
      i. Set the duration
      ii. Define the mode (public or restricted)
   (b) Define the robot(see Figure 3.d)
      i. Select which robot and module to use
      ii. Upload the programs
      iii. Assign the program to each robot
   (c) Enable your experiment and execute it(see Figure 3.e)
4. After the experiment is finished, go to archive menu to get the data (see Figure 3.f)

Possible application: will follow...

4.5 Running Registered Experiments Using Robots and Virtual Robots

This scenario is basically the same as the previous scenario. However, not only robots but also one or many computers are used, similar to scenario in 4.3.

Possible application: will follow...

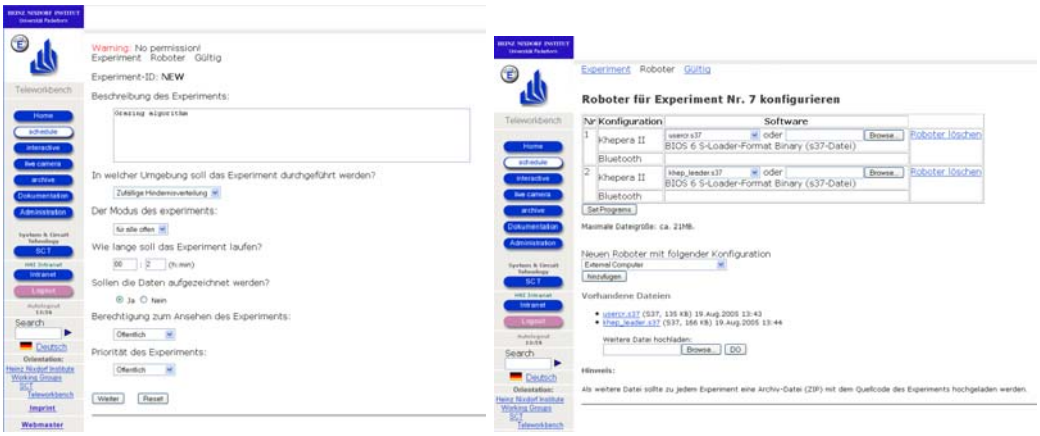
5 Output of Teleworkbench

There are several data produced by Teleworkbench . However, the accessibility depends on the type of users, whether they are registered or unregistered users. Table 1 shows the output data along with its accessibility.

Login
Username: tanoto
Passwort:
Login
Passwort vergessen ?
Warning: No permission!
Neues Experiment anlegen
Nr User Roboter Laufzeit Beschreibung Status
2 Andry Tanoto 2 00:01 Wall following on two robots. wartet auf Start (4) view Info
3 Andry Tanoto 1 00:01 Wall following with 2 robots with sensor and position data sent by the robots. wartet auf Start (4) view Info
4 Jia Lei Du 2 00:10 wartet auf Start (4) view Info
5 Andry Tanoto 1 00:02 Download program which tells the robots to go to some target points. wartet auf Start (4) view Info
6 Andry Tanoto 2 00:03 Leader and Follower wartet auf Start (4) view Info

(a) Schedule login.

(b) Schedule Menu.


Warning: No permission!
Experiment Roboter Gültig
Experiment-ID: NEW
Beschreibung des Experiments:
In welcher Umgebung soll das Experiment durchgeführt werden?
Der Modus des experiments:
Wie lange soll das Experiment laufen?
Sollen die Daten aufgezeichnet werden?
Berechtigung zum Ansehen des Experiments:
Priorität des Experiments:
Roboter für Experiment Nr. 7 konfigurieren
Nr Konfiguration Software
Neuen Roboter mit folgender Konfiguration
Vorhandene Dateien

(c) Define the experiment.

(d) Define the robot, robot module, and program.

(e) Enable the experiment and execute it.

Figure 3: Set-up Experiment.

References

[1] Teleworkbench: Paper

[2] Teleworkbench Project Home Page, http://wwwhni.upb.de/sct/twb/index_e.php

[3] Quicktime Player & Plugin, http://www.apple.com/quicktime/

[4] GPAC Project Home Page, http://gpac.sourceforge.net/

[5] MPEG4IP Project Home Page, http://www.mpeg4ip.net/

[6] Darwin Streaming Server, developer.apple.com/darwin/projects/streaming/

List of Commands of Teleworkbench

Position

The following are list of command related to robots' postion. Important to note, each command is preceded by ***P***.

1. **A: number of robots**
   A,number of webcam/field
   0 .. over all fields
   Answer: a,number of robots
2. **F: get field where the robot is**
   F,robot-color-id
   Answer: f,field-number
3. **I: color-IDs of robots**
   I,number of webcam/field
   0 .. over all fields
   Answer: i,id1,id2,id3,....,idn
4. **P: position of a robot**
   P,robot-color-id
   Answer: p,x,y,alpha
5. **T: time when the robot was found robot**
   T,robot-color-id,time-format
   time-format:
   .. before x ms
   0 .. before x ms
   1 .. at x ms
   2 .. now in ms
   Answer: t,time

Robot

The following are list of command related to commands for robots. Important to note, each command is preceded by ***R***.

1. **A: allocate robot**

   A,robot-id,mode

   mode = 0 color-id

   mode = 1 com-id

   Answer: a,handle

   -1 .. false

2. **B: get robot BIOS version**

   B,robot-id,mode

   mode = 0 color-id

   mode = 1 com-id

   Answer: b,answer

3. **C: command to robot**

   C,handle,robot-com-id,command

   Answer: c,answer

4. **F: free robot**

   F,handle,robot-com-id

   Answer: f,status

   -1 .. error

   0 .. false

   1 .. ok

5. **S: status of robot**

   S,robot-id,mode

   mode = 0 color-id

   mode = 1 com-id

   Answer: s,status

   -1 .. no such robot

   0 .. free

   1 .. used in experiment

   2 .. used by other user

Webcam

The following are list of command related to controlling the webcams. Important to note, each command is preceded by ***W***.

1. **A: status**

   A,number of webcam

   Answer: a,number of status

   -1 .. no such Webcam

   0 .. Webcam is off

   1 .. Webcam is streaming

   2 .. Webcam will do down

2. **Q: run Webcam without logging**

   Q,number of webcam

   Answer: q,number of status

   -1 .. error

   0 .. Webcam is off

   1 .. Webcam is on